SCIENCE SERVING AGRICULTURE

THE UNITED STATES DEPARTMENT OF AGRICULTURE—

GREATER TEXAS
AND PAN-AMERICAN EXPOSITION
1937

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DEPARTMENT OF AGRICULTURE

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By

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The United States Department of Agriculture Touches Your Life in Scores of Ways

EVERY day the United States Department of Agriculture does for you a multitude of necessary things that you could not possibly do for yourself. It guards your food supply from adulteration and dangers to health and improves its quality through plant science and animal husbandry. It keeps watch on production at home and abroad, so that supply may be adjusted to demand and prices kept in line with values. It standardizes and grades commodities, seeks uses for waste products, protects the forests and wild life, defends the country against foreign insects and animal and plant diseases, maps the Nation's soils, studies how our land resources may be better utilized, forecasts floods, storms, and frosts, and supervises road construction. The progress of science and civilization makes these services indispensable, while at the same time removing them from the sphere of individual action.

On rising you reach for the tooth paste or a mouth wash. You can not personally know that the article is fit to use. The Department guarantees that it is what the label says. Perhaps you take a medicine for some minor ailment; the Department guarantees the strength and purity of the contents. At breakfast you eat a slice from a ham bearing a little purple stamp. This assures you that the ham came from a healthy animal slaughtered under Federal inspection in sanitary surroundings. The cream on your cereal came from a dairy using practices standardized by the Department. The cereal has stood the test of the pure food law. Your bread is from grain graded by Federal standards. Your fruit, no matter what its kind or variety, shows the results of the Department's scientific labors. It doubtless owes its size, flavor, and other characteristics to the plant breeders. Sprays devised by the Department protected it from insects and fungous diseases.

Consider your cotton tablecloth. The Department explorers found our best cotton varieties in distant lands. Its plant breeders and textile specialists made important technical contributions to the cotton-textile industry. Every bit of the fabric embodies the results of their work. Your coffee or tea, though not produced in this country, passed Federal inspection, so that you may know that it is not adulterated.

On the first page of your newspaper the Department's weather report tells you whether it will rain, shine, or blow. You are interested if you are a fruit grower, a farmer, or a truck driver. You are interested if you have perishables to transport, a building to erect, a road to build, or a trip to make by motor, ship, or airplane. On the financial page you will find the Department's crop and market reports. As the season advances you can learn what the harvest will be, because the Department gets crop news from more than 400,000 crop reporters scattered over the country.

Your newspaper will contain also articles giving Federal reports on shipments, prices, and market conditions. Were such information not published, speculators would have things their own way. On the women's page you will find scientifically balanced menus prepared by the Department's nutrition experts. Food knowledge stretches the food dollar and protects the national health. Ignorance about food, on the other hand, takes heavy toll in sickness and depleted energy.

Perhaps you contemplate an auto trip. It will carry you over roads built on plans sometimes originated and certainly approved by the Bureau of Public Roads. If it is a holiday jaunt, it may take you into the national forests, policed, protected from fire, and administered by the Forest Service, with recreational as well as economic objects in view. Do you hunt? Then you owe a debt to the Bureau of Biological Survey, which protects wild life for sport as well as for its money value. Game birds and animals would soon be exterminated were they not protected.

Mention of these services gives only a faint notion of what they mean. Guarding the meat supply is not simply a question of condemning unhealthy animals. More important is the production of healthy ones. The Department fosters this by excluding foreign livestock diseases and combating diseases that exist here. It incessantly fights cattle-tick fever, hog cholera, and bovine tuberculosis. It also conducts experiments on methods of improving livestock by breeding, feeding, and management.

Food and drug inspection does more than protect you against poisonous, adulterated, or misbranded goods. It discourages the unscrupulous manufacturer and aids the worthy one, so that standards of food and drug production continually improve. Administration of the food and drug law guards your pocket as well as your health. Commodity standardization by the Department facilitates trade, prevents disputes, and encourages quality production. Without a uniform national yardstick to measure variations in the quality of farm products and provide a basis for trading, producers would have small incentive to emphasize quality.

Primarily the Department of Agriculture is the farmer's branch of the Government. Its first thought is to help solve the farmer's problems of production, farm organization, and marketing. Agricultural investigations naturally bulk largest in its work. But promoting agricultural welfare advances the general welfare. Even in helping the farmer to conserve his soil and to produce better crops at a lower cost, the Department benefits the nonfarmer.

Sometimes, indeed, the nonfarmer profits most. Science applied to agriculture assures him dependable food supplies. It assures the producer a profit only when it is accompanied by good adjustment of production to demand.

In many ways the Department aids nonagricultural interests directly. Its chemical investigations, for example, have numerous industrial applications, such as in the prevention of dust explosions, spoilage, and waste. Business and finance have a vital interest in the Department's services. Buyers and sellers watch the monthly crop forecasts, and greatly value the scope and accuracy of the information. Farm purchasing power depends on production and prices. Industries that

sell goods to farmers accordingly want the farm-income data which the Department furnishes. Financial agencies serving agriculture benefit as much as the farmers themselves from whatever diminishes the risks and increases the profits of farming. It would be difficult to name a business group that derives no benefit from some of the Department's technical and economic information.

The Department's development was not planned in advance. No one had the necessary foreknowledge. It evolved from small beginnings, but not fortuitously, without curb, control, or system. It met new requirements, while at the same time observing the demands of economy and efficiency. Throughout the years it has coordinated research, guarded against overlapping in service activities, and consolidated functions for convenience, efficiency, and economy.

Scientific research is the Department's biggest job. In fact, scientific research is the foundation of all its other jobs. One might not realize this in glancing over a list of the activities. Such a list might group the principal items into (1) research; (2) extension and information; (3) eradication or control of plant and animal diseases and pests; (4) service activities, such as weather and crop reporting; (5) administration of regulatory laws; and (6) road construction. This classification, though useful and necessary for certain purposes, makes research look like only one among many equally important functions. Actually, it is the keystone of the structure. Indeed, research enters into everything the Department does. It could not, for example, get very far in the eradication or control of plant and animal pests without research.

Hence a glance at some of the big things accomplished by the Department through research should illustrate the character and usefulness of the institution as a whole. It was recognized long ago that agricultural research is logically a public function. This is because few individuals or even groups have the scientific interest, the public spirit, the money, or the economic incentive to do it well. As a private enterprise agricultural research generally does not pay, since the benefits cannot be monopolized but must be shared with the community. Publicly conducted, however, it pays handsome dividends. It is one of the greatest sources not only of wealth but of welfare. In the United States some of the State universities and some of the endowed colleges were pioneers in agricultural research.

In the organic act creating the United States Department of Agriculture, Congress directed the institution to acquire and diffuse information on subjects connected with agriculture in the most general and comprehensive sense. We cannot always measure the value of the work in dollars and cents. It is too widely diffused and too complex for any such accounting. But we can sense its nature and form some impression of its extent and variety by noting some of the high spots in the record.

Naturally the Department must communicate the results of its research work to the public. Accordingly, the Department maintains various information services. These include a cooperative extension service, a division of publications, press and radio services, weather services, crop and market reports, motion pictures and exhibits, and correspondence with individuals.

How Uncle Sam Began Fighting Livestock Diseases

IN 1843 Peter Dunn, a milkman located near South Ferry, New York City, bought a ship cow from the captain of the English ship *Washington*. This cow had contagious pleuropneumonia, an insidious and destructive disease. It carried the infection to Dunn's herd, whence the malady spread to other herds nearby. Owners seemed not to recognize the disease, or at any rate they kept quiet about it. Long prevalent in other countries, it was known there and greatly dreaded. No large nation had ever succeeded in stamping out an extensive infection. From New York and Brooklyn the infection spread to New Jersey.

Another infection broke out in 1859 in Massachusetts, where it had been introduced by four cows imported from the Netherlands. These cows were sick when they arrived in Boston, and in this case the disease was quickly recognized. Nevertheless, the infection escaped to other herds in the vicinity and within 4 years the disease had appeared in 20 towns in Massachusetts. The Massachusetts General Court passed an act providing for the appointment of a commission to combat the disease. By quarantining exposed herds, slaughtering and burying infected cattle, and cleaning and disinfecting premises, the Massachusetts authorities freed the State of the disease by 1864, but not before it had spread to other States. Soon it became established in Connecticut, Delaware, Pennsylvania, Maryland, Virginia, and the District of Columbia. Veterinarians emphasized the necessity of wiping out the malady while it was yet confined to narrow limits along the coast, but nothing effective was done.

Not until 1879 did livestock men and national authorities become aroused to the danger. Then they were stirred up, not so much by the progress of the disease in the United States as by an alarming step taken by the British Government. By an order of the Privy Council, dated February 6, 1879, the British Government decreed that all American cattle arriving in English ports should be slaughtered on the docks within a limited time. This action forced the price of an American steer in the English market about $10 below the price paid for similar cattle shipped from Canada. Our export cattle trade was then mounting and a promising export movement of dressed meats had begun. Our livestock industry had grown to a point that made an export outlet indispensable. In putting restrictions on the trade Great Britain caused our cattle industry a loss of at least $1,000,000 annually. Estimates indicated that this amount would have been enough to clear the United States of contagious pleuropneumonia. Alarmed by the prospect of losing their export trade, livestock men demanded control measures.

First they sought State action; but this did not work very well. As already noted, Massachusetts had stamped out the disease, and Connecticut had repelled numerous invasions from New York. Other States, however, had little success

in control measures. They could not get together on purpose and policy. Cattle owners in some sections hid the existence of the disease and sold affected animals. State laws were unequally enforced.

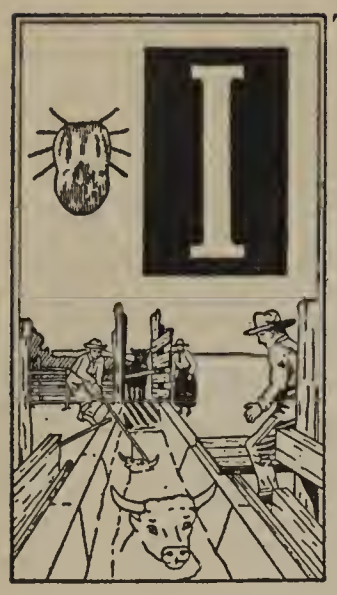
It was clear that nothing could be accomplished without vigorous, uniform, and centrally directed action. So an insistent call for active Federal intervention arose. Before the National Government could act, however, it was necessary for Congress to pass laws, provide funds, and create an administrative organization. This was not an easy thing to get done. Up to that time the livestock industry had been left to drift without much help either from the States or from the Federal Government. It was not considered a proper Government function to deal with the production and shipment of livestock. Opponents of Federal action warned against infringements on the authority of the States, and urged Congress not to create an army of job holders or a political machine. They even questioned the presence of pleuropneumonia in the United States, and ridiculed the veterinary profession, then struggling for recognition.

When William H. Hatch, of Missouri, then Chairman of the Committee on Agriculture, introduced in 1884 a bill to establish the Bureau of Animal Industry, opponents of the measure poured scorn upon it as the "horse doctor bill." These arguments, however, could not withstand the rising tide of opinion in Congress and throughout the country that Federal action was necessary. Livestock men realized that a destructive disease which had spread throughout the Northeastern States might become forever uncontrollable should it reach the herds on the unfenced western plains. They saw that State action, working inefficiently at cross purposes and without concerted aim or uniformity, would waste time and money to no purpose. Accordingly, Congress in May 1884 passed legislation establishing the United States Bureau of Animal Industry. It was evident from the wording of the act that the new Bureau's first duty would be to take charge of the eradication of pleuropneumonia in cooperation with State authorities. This task was accomplished within 5 years, and the disease has never since gained a foothold in the United States. The achievement was noteworthy from many standpoints.

For it was not against contagious pleuropneumonia alone that the country needed concerted action. From 25 to 30 million dollars worth of hogs were dying annually from hog cholera. Bovine tuberculosis and contagious abortion were spreading, as likewise were anthrax and blackleg. Tick fever had seriously alarmed cattle raisers, and the public had begun to demand better protection in connection with the meat supply.

By its victory over contagious pleuropneumonia the Bureau indicated the right course to pursue against these other diseases. The last case of contagious pleuropneumonia was found in northeastern New Jersey on March 25, 1892. All told, the eradication work cost the National Government $1,509,100, as compared with an estimated saving to our livestock men thus far of fully $41,000,000 because of the British regulation alone. There has also been an additional saving due to the absence of losses from the disease in the United States.

Medicine Revolutionized by Cattle-Fever Discovery



IT probably never occurred to you that the United States succeeded in building the Panama Canal because of a scientific discovery made by a Department of Agriculture scientist in 1886. Does it sound altogether too astonishing? Yet France failed to build that Canal, not because she lacked intelligence, courage, or perseverance, but because she did not know how to control yellow fever. The United States succeeded at the same job because its workers could control yellow fever. Yellow fever was controlled because a scientist in the Bureau of Animal Industry found in 1886 that the presence of the cattle tick was essential in the transmission of cattle-tick fever. If that all sounds like a fantastic mystery story, it can nevertheless be explained very logically.

Cattle-tick fever, introduced in colonial times from the West Indies and Mexico, caused tremendous havoc during the greater part of the nineteenth century. Outbreaks occurred not only in the South, where the disease was continually present, but in many Northern States. Observers noted that southern cattle, though apparently not sick themselves, left a trail of the disease when they were driven north. Cattle raisers in the North demanded action. State laws and regulations imposed quarantines, but outbreaks continued in many States and cattle owners generally were in consternation. No one knew a remedy. Why only southern cattle communicated the plague, why it disappeared in winter, and why the northern animal sick with the disease could not spread it, baffled scientist as well as layman. Farmers suspected the cattle tick had something to do with the disease, but scientists at first scouted the idea.

In 1884 the Bureau of Animal Industry placed Dr. Theobald Smith in charge of animal-disease investigations. Four years later Dr. Smith noticed the destruction of the corpuscles in the blood of cattle sick with this fever. Seeking the cause, he confirmed a discovery made in 1886. He found a peculiar micro-organism, a protozoon, in the red blood corpuscles. In the same year Dr. F. L. Kilborne, of the Bureau of Animal Industry, proved that the presence of the cattle tick is essential in the transmission of the disease.

Dr. Cooper Curtice, also a member of the Bureau, then began to study the life history of the tick. He placed young ticks on northern calves which became sick with the cattle fever. Thus it was definitely proved that the tick carried the infection from one animal to another. Up to that time, however, the infective agent had not been observed in the body of the tick. Koch in 1906 discovered developmental stages of the micro-organism in the female of an African variety of the cattle tick. Ten years later an investigator in this Department found the micro-organism in American cattle fever ticks and their eggs.

This series of brilliant discoveries, besides indicating the proper control measures for cattle fever, led to beneficial achievements in medicine. Tick fever, as the investigations demonstrated, attacks the victim exclusively through a host or carrier. Cattle get tick fever through being bitten by the fever tick and in no other way. They cannot catch it from the air, nor from their feed, nor from their drinking water, nor from contact with another animal. Cattle fever was the first disease proved to spread in only this way, but it was not the last. The new knowledge led to practical control measures, which have eradicated cattle ticks from 12 of the 15 Southern States formerly infested. It led also to the discovery that other dreaded diseases, including yellow fever, malaria, African sleeping sickness, Rocky Mountain spotted fever, and nagana, are carried through an intermediate host. It disclosed the role of the mosquito in the transmission of yellow fever, and thus enabled Americans to build the Panama Canal with comparatively small loss of human life.

In 1902 Dr. Charles Wardell Stiles, a zoologist in the United States Department of Agriculture, discovered the New World hookworm of man, now known as *Necator americanus*. He also recognized it as the cause of much of the apparent laziness and shiftlessness of certain elements of the rural population in the southern part of the United States. This discovery aroused great interest in this country. It was directly responsible for most of the improvements in rural sanitation, especially in the South, which have taken place during the past 30 years. Ultimately it led to a world-wide campaign against hookworm disease, which has been greatly aided by the International Health Board of the Rockefeller Foundation. Attention was focused on soil pollution as a source of hookworm disease, and this aroused interest in other parasitic and bacterial diseases of man that are spread through contaminated soil.

In 1921 Dr. Maurice C. Hall, a member of the Department, announced the discovery of a new treatment for hookworm disease, namely, the use of carbon tetrachloride. This compound, previously used as a fire extinguisher and a remover of grease spots from clothing, removed hookworms from dogs. By experiments on himself Dr. Hall ascertained that chemically pure carbon tetrachloride in a therapeutic dose is well tolerated by man. Then he proposed it for the treatment of hookworm disease. Almost overnight the new drug became the standard remedy. Millions of persons all over the world have been treated with carbon tetrachloride, and the fatalities have been practically negligible.

A later discovery by Dr. Hall in collaboration with Dr. J. E. Shillinger, showed that tetrachlorethylene, a compound related to carbon tetrachloride, is even more efficacious than carbon tetrachloride in removing hookworms from dogs. Moreover, it has a higher safety factor. This new drug has been tested on thousands of human beings without any fatalities. Tetrachlorethylene probably will replace carbon tetrachloride in the treatment of hookworm disease in man.

The final chapter on the hookworm still remains to be written. While considerable progress has been made, the complete conquest of this malady has not yet been achieved. It is important to continue the attack.

Insects Proved Guilty of Spreading Plant Diseases

WHEN you think of contagious diseases and quarantines you naturally think of men and animals. But plants also suffer from contagious diseases. Such diseases are frequently transmitted among human beings by insects. The same thing is true of plants. That very important and fundamental fact was discovered by Department of Agriculture scientists.

It had previously been suspected, but not until 1891 was positive proof obtained. An investigator studying pear blight produced the disease experimentally by brushing the germs of the disease into a number of pear blossoms. The germs multiplied in the nectar and entered the nectaries, which have no protecting cuticle. Why the disease often developed almost at once on the whole bloom of a tree, however, was still a mystery. It was solved one morning in the Department's grounds at Washington, when the investigator saw a honeybee alight on a pear blossom. It sucked up the nectar and flew to another flower. Instantly the investigator realized that here was the agent carrying the blight from flower to flower and from tree to tree. Here was the explanation of the rapid, devastating distribution of pear blight on the blossoms and perhaps on other parts of the tree.

The investigator got some sterilized test tubes and caught three bees in the act of sipping the infected nectar. Examining them under a microscope, he found the germs on their mouth parts, and from these germs he developed cultures. The organisms were true pear-blight organisms; they produced pear blight when inoculated into pear trees, and the disease so produced developed the same organisms again. This discovery influenced plant pathology greatly. It threw light also on certain previously obscure problems in the transmission of disease to animals. Eventually it became evident that birds and other animals as well as insects carry pear blight.

Many plants with perfect flowers, however, are sterile to their own pollen, and require insect pollenizers to perform the act of cross-pollination. Various elaborate experiments showed that the insects are necessary to many varieties of pear and apple blossoms, even if they do spread disease. Scientists had to drop the idea of banishing the bees, and to try other methods of controlling the pear blight. No perfect control has yet been devised. Some varieties of pear are fairly resistant to the disease, and orchardists also fight it by removing blighted material from the trees and disinfecting the wounds. Growers still have a hard fight producing Bartlett, Anjou, Bosc, and other susceptible varieties grown for the high quality of their fruit. Plant breeders can develop a fair degree of blight resistance, but they have difficulty in combining this characteristic with other desired features. In the conquest of plant diseases, however, a necessary step is to find out how they are transmitted.

Plant Breeders Restore Sugarcane Industry

HEN Etienne De Bore, hopefully expectant beside his open sugar kettle on the banks of the Mississippi River, saw crystals forming in the cane juice and shouted "It granulates!" he envisaged a long-continued prosperity for himself and his French neighbors and perhaps for their children. But it is not likely he even dreamed that 1½ centuries would pass before the first natural crisis would threaten the sugarcane industry. The plantation homes, famous for their luxury, the planters noted for their culture and hospitality, and the beautiful, rippling oceans of sea-green cane withstood the assaults of free-trade exponents and actual invasion by hostile armies in two wars, only to be brought to the verge of ruin by a physical enemy that cannot be seen even with a microscope.

The Department of Agriculture was called upon in 1919 to tell why yields of cane were falling off in sections of Louisiana where the welfare of whole communities depended upon this crop. It discovered that the trouble was an infectious disease, caused by an ultramicroscopic virus, and transmitted from plant to plant by a tiny insect, the corn leaf aphis, much as malaria is transmitted by a mosquito. Inexorably the malady advanced through the agency of this insect, at a rate that meant involvement of the entire acreage devoted to sugarcane and utter ruin of the industry within a few years.

A race began, with no crack of starter's gun and no multitude of enthusiastic onlookers. The contestants, ruthless nature and enlightened science, were equally determined. The purse was that historic landmark of American agriculture, the sugarcane industry of the South. Mother Nature led, most of the way. Before the backstretch was reached she indifferently viewed the havoc caused by the decline from 15 to 6 or 7 tons of cane per acre, the abandonment of more than 50 percent of the formerly productive Delta, and a sheer drop in sugar production from 250,000 tons annually to less than 50,000 tons. The banks refused to bet on science, rated as a long shot in 1926, and the race appeared to be over.

The Department had anticipated these developments and had started research during the first year of the disease epidemic. Field studies supplemented by laboratory and greenhouse experiments indicated the unusual nature of the disease, its peculiar manner of spread, and other essential biological facts. Direct treatment of plants or therapeutic measures are impracticable in the case of field-crop diseases. Investigators carefully considered the possibility of controlling the insect carrier, but the leaf aphis lives and breeds mainly on wild vegetation and is out of reach because of the extent and character of its many refuges.

There was a chance of finding varieties of cane that would not take the disease or would tolerate the infection without severe injury. This line of attack seemed the most promising. The American Continent, however, yielded not a single

stick of cane that showed the slightest resistance to mosaic, as the disease was called. In the quest for resistant canes, plant explorers combed most of the civilized sugar-producing countries in the Equatorial Zone, and extended the search by airplane even to the heart of Papua, that vast island practically unknown to white men, lying in the sweltering Tropics north of Australia.

Their reward was as heartening as Etienne De Bore's anxiously waited reward of crystals. Today 230,000 acres, representing most of the cane land used for sirup production and all the land used for cane-sugar production, are planted to immune or resistant varieties in part introduced from Java where they had been bred by the Dutch investigators and in part bred in this country and distributed by the Department.

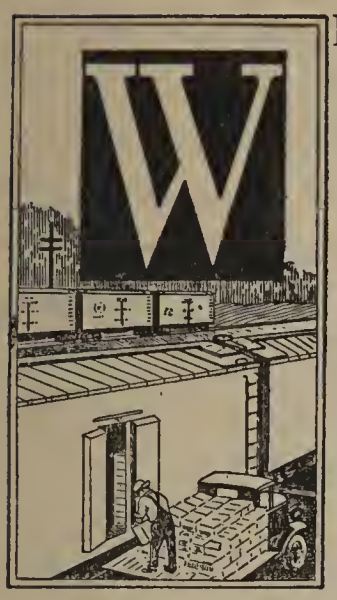
The new varieties include hybrid seedlings bred by the Department at its field station in southern Florida and varieties assembled from remote countries. Yields per acre are as high or higher than those of the old varieties used before the epidemic, and production of sugar again exceeds 200,000 tons.

The new varieties possess desirable characteristics in addition to the high yield due to their disease resistance. Formerly, about one sixth of the crop had to be used as seed cane. The seed-cane requirement totaled over 500,000 tons annually. Seed cane required for the resistant varieties is much less than half that amount, because it has a greater number of eyes or buds per unit of weight, and because of other inherent qualities that result in economies in planting material. More than 250,000 tons of cane that formerly went into the ground for propagating purposes is now converted into sugar, sirup, and by-products and represents a net gain of more than a million dollars every year for the farmers engaged in sugar-cane culture. There is also a considerable saving of labor in planting.

Cooperation between the Department and State experiment stations has yielded a big harvest in sugar-beet investigations. American farmers pay more than $2,000,000 annually for sugar-beet seed, mostly to foreign seed producers and distributors. Experiments at the New Mexico Agricultural Experiment Station demonstrated that in the mild climate of the Rio Grande Valley seedlings from seed planted in the fall may be overwintered in the field and brought to satisfactory seed production the following year. By the method commonly employed, mother beets must be lifted in the fall, carried over the winter in silos or pits, and replanted in the spring. The overwintering methods has many advantages. Besides speeding the production of seed and reducing the cost, it promotes the development of disease-resistant varieties. European beet seed has no resistance to the curly-top disease, which is native to the United States and threatens the sugar-beet industry west of the Rocky Mountains. Home production of sugar-beet seed by the overwintering method, which is possible on a commercial scale, greatly aids in the development of resistance to curly top.

Only recently the Department announced an important triumph in the struggle against this plant disease. It developed a beet (known as U.S. no. 1) which is far more resistant to curly top than is any beet commercially grown in the western sugar-beet regions.

Refrigeration Studies Lower Shipping Costs



WHEN you refresh yourself with a nice, juicy, California-grown Valencia orange on a hot midsummer day in Chicago or New York or anywhere in the Eastern States, do you ever stop to think that it had to be shipped through hot desert regions, hauled up over the Rocky Mountains and across the broad stretches of the Great Plains—a distance of 2,000 miles or more? Do you ever wonder just how oranges must be handled in such shipments to reach you in such fine fresh condition that you could hardly tell they had not been picked fresh from the tree?

If you have given the matter any thought, doubtless you have commended the methods of transportation employed and—in view of your monthly bill to the ice man, or perhaps the monthly installment on the new electric refrigerator at home—have concluded that the transit refrigeration must be a rather expensive item of service, especially when applied to California's crop of some 70,000 carloads of oranges. As a matter of fact this is what the California growers concluded a few years ago when they asked the Department to start an investigation to develop more economical but equally satisfactory methods of shipping oranges to eastern markets.

At that time the prevailing practice, upon which transit refrigeration costs were based, was to load the fruit into the cars at the packing house, after which they were moved to a central icing station. There the bunkers of the refrigerator cars were filled with ice—about 5 tons per car being required. There also 50 or 60 cars of fruit were assembled into a solid trainload which was started eastward. About once in every 24 hours thereafter this train had to be halted at an icing station to replenish the melting ice. These halts took practically an extra day's time in transit. Shipments to New York required about 10 reicings.

In its investigation, which has just been completed, the Department of Agriculture demonstrated, first, that low temperatures are more important for the fruit at the time of loading than at the time of delivery. It also proved that when oranges are cold to start, less ice is needed in transit, and in fact that shipments that are cold when they start usually need be reiced but once in transit to arrive in as good condition as those forwarded by the old method of reicing every 24 hours.

It was found that prompt initial cooling could be accomplished by loading the fruit into cars which are already iced and cooled instead of delaying the icing until the cars reach the central icing station, frequently the next day after loading. It was found that the cooling from this initial ice load is well sustained for the first 3 or 4 days, by which time the shipment is over the Continental Divide and usually encounters cooler weather. One reicing at this time usually carries the shipment into New York, with some ice left in the bunkers but without the former useless excess.

Disease Resistance Bred in Lettuce Averts Disaster

HOW much would you be affected if you could not get the crisp head lettuce that reaches such perfection in our southwestern and Pacific coast areas? What if some inescapable plant disease should ruin the 100,000 odd acres of winter lettuce that constitute over half the total acreage grown for sale? These are real questions that faced the country a few years ago, and which the Department was called upon to answer. The 175,000-acre lettuce crop is a minor farm product, but it is worth some $30,000,000 to $35,000,000 a year.

In the Southwest, where some 20,000 to 25,000 carloads of winter lettuce are grown annually, a destructive disease called brown blight appeared. This disease caused the plants in affected fields to become yellow, stop growing, and finally die. It lives in the soil for many years. Once it gets into a field, lettuce cannot be successfully grown there. There was no way to control the disease. The only way to avoid it was to plant lettuce on land free from the disease. It spread rapidly, and the suitable disease-free areas were rapidly becoming exhausted. Yields were decreasing and an important industry of a large region was apparently doomed to destruction.

During the early stages of this development the Department launched an effort to avoid the impending disaster. I. C. Jagger, a Department scientist, produced by selection and by breeding a number of strains of lettuce that appear practically the same as the variety New York but which are very highly resistant to brown blight.

Successful crops of these new sorts, named Imperial no. 2, Imperial no. 3, and Imperial no. 6, can be grown on soils infested with brown blight where the old variety would be a total financial loss.

These new varieties, while practically immune to brown blight, were highly susceptible to mildew, another serious disease of lettuce in the Southwest, and so were of little value where this additional trouble was prevalent. Again, Mr. Jagger developed new varieties—this time, resistant to two diseases, and therefore called "double-resistant" sorts. He obtained these double-resistant varieties by first making crosses between the mildew-susceptible New York variety that was commonly grown, and a Cos or Romaine variety from France that was commercially worthless in the region but highly resistant to mildew. Selections from this cross were highly resistant to mildew and of good quality. Certain of these selections were then crossed with the brown-blight resistant varieties, Imperial no. 2 and Imperial no. 3. Selections from these latter crosses finally resulted in the double-resistant strains, Imperial C, Imperial D, and Imperial F.

From 75,000 to 80,000 acres in the Southwest were planted with these various resistant strains last season. They returned $4,000,000 to $5,000,000 to the lettuce growers, even at the low prices then prevailing.

Length of Day Shown to Influence Plant Growth

WHY is it that certain plants ordinarily flower only during the winter, while others regularly flower in the spring, still others in midsummer and still others only in late summer or fall? Even in the same species one variety or strain may flower and fruit weeks or months in advance of another variety planted on the same date.

Another related and equally interesting question is: Why do plants frequently show such remarkable changes in their habits of growth when grown in different latitudes? For example, some species when transported from the Tropics to high latitudes grow with extraordinary vigor and attain great size but lose the power to blossom and set seed. Plant physiologists in the Department have answered these questions in large measure.

The investigators started with the fact that in the latitude of Washington, D.C., a newly discovered Maryland variety of tobacco continued to grow vigorously through the growing season and produced excellent yields, but failed to flower. When grown in the greenhouse during the winter months, this variety readily flowered and set seed. It had been observed also that certain late-maturing varieties of soybeans, whether planted early or late, always tend to flower at a certain time in early fall. After having failed to find any relation between these observations and the seasonal changes in temperature, light intensity, or humidity, the scientists tried artificially shortening and lengthening the daily light period. The results were remarkable. It proved easy to induce or suppress reproductive activity. Tests on many other plants showed that response to changes in day length is of exceedingly wide application. The effect is not limited to flowering and fruiting. It includes such features as the formation of tubers, leaf development, and branching and growth of the main stem. Plants differ greatly in their day-length requirements. Contrary to older conceptions, not all plants do best under a long day or continuous light. With respect to flowering and fruiting, one principal group requires a short working day and a long night, such as prevail during the late summer, fall and winter or at low latitudes. These are called short-day plants. The second major group includes the long-day plants, which for free flowering and fruiting require a long working day such as prevails in late spring and midsummer, especially in high latitudes. A third, smaller group of plants is capable of flowering and fruiting more or less readily under either a long or a short day. This is the neutral or indeterminate type.

The pioneer work in the Department on the effect of day length has been confirmed by numerous investigators in various parts of the world. More than a hundred technical papers on the subject have appeared. By proper regulation of the daily period of light and by providing suitable conditions of temperature and other environmental factors, it is now possible to largely control the rate, amount, and character of growth.

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Plant Explorers Bring Treasures From Abroad

PLANT explorers from the Department, searching in southern Mexico for weevil-resistant cotton, made a great find there in 1906. Southern Mexico is the native home of the boll weevil. It was natural to expect that the cottons grown in the region would have more weevil resistance than cottons grown where the insect had not been long established. Accordingly, the explorers made journeys by muleback to scores of remote places looking for varieties worth trying in the United States. In the town of Acala, in the central part of the State of Chiapas, they discovered a variety that is now grown in all the irrigated valleys of California, Arizona, New Mexico, and western Texas, in many districts farther east in Texas, and in Oklahoma, Arkansas, Tennessee, and other cotton-growing States.

Investigators did selection and acclimatization work with the new introduction for 4 years near San Antonio, Tex., before experimenting with it in field plantings. It gave good yields in its first field tests, and soon attracted the attention of growers. In fact, the new variety, known as Acala, became popular too quickly. The demand could be supplied only with mixed seed, much of it so poor that some reputed Acala fields showed only scattering plants of the true Acala type. Farmers were disappointed; and the initial popularity of the new variety declined as rapidly as it had risen. But the scientists were not discouraged. They knew what Acala could do under the right conditions.

Accordingly, they attacked the problem of establishing pure seed stocks. This was an indispensable means of preserving the variety. Representatives of the Department located communities in California where it seemed probable that regular supplies of good Acala cottonseed could be maintained unmixed with the seed of other varieties. The first Acala-cotton communities have the protection of a special act of the California Legislature, which establishes pure-seed districts for Acala cotton and makes it unlawful to interfere with the production of Acala by planting other varieties. The one-variety communities make possible the production of large supplies of pure seed.

Cotton plantings in the irrigated valleys have ranged in recent years from 400,000 to 800,000 acres. Practically the entire acreage in all the larger valleys is Acala cotton. Acala districts are being established also in the main Cotton Belt. One-variety communities devoted to the production of Acala cotton exist in Texas, Oklahoma, and other States. The variety is one of the earliest and most prolific of the upland type. It has large bolls and a fiber that is abundant and even on the seeds. In staple length it ranges from 1⅛ to 1$\frac{3}{16}$ inches under favorable conditions. It is suited to weevil-infested regions as well as to short seasons along the northern rim of the Cotton Belt, because it produces good crops in a relatively short time.

Acala is only one of scores of valuable agricultural plants introduced into the United States by the Federal Government. Plant-introduction work goes back to colonial times. Benjamin Franklin, when he was in England as agent of the Colony of Pennsylvania, sent home silkworm eggs and mulberry cuttings to start the silkworm industry, also specimens of seeds and plants that he thought might be adapted to this country. This action encouraged American consuls abroad to do likewise. Jefferson as the first secretary of State took great interest in the introduction of plants and animals. After the creation of the Department of Agriculture in 1862, plant-introduction work expanded greatly. As a matter of fact all our field crops, except tobacco and corn and a few minor crops, have been introduced from foreign countries. Not even the potato is native to the United States; its original home is below our southern boundary.

In the last 35 years or so, the Department has systematized and scientifically controlled the plant-introduction work and the benefit has been tremendous. Among the important crops started from plant introductions are numerous citrus fruits, durum wheat, Sudan grass, soybeans, many varieties of vinifera grapes, Persian walnuts, and figs. Explorers from the Department seek valuable new plants in all parts of the world. Entomologists and pathologists here carefully inspect each shipment on its arrival for pests and signs of diseases, and plant breeders adapt the introductions to American conditions.

The crops introduced include several not previously grown in this country, and not competing with any other crops grown here. Among them are the Washington Navel orange, which gave the initial impetus to California's orange production, numerous varieties of the avocado, the mango, Chinese and Japanese persimmons, the papaya, and the pistache nut. These introductions diversify our agriculture in ways largely noncompetitive with existing crop production.

The date industry, scarcely 25 years old in the United States, originated with the introduction by the Department of the choicest dates from Old World gardens. It has a noncompetitive domestic market because the United States imports more than 20 times as many dates as it grows. American dates are so superior in quality that they have opened new markets, without as yet diminishing the demand for imported dates.

Another promising new and noncompetitive crop is an early-ripening strain of the Satsuma orange. This orange, recently introduced from Japan, ripens in the Gulf coast region between the middle of September and the last week of October, in which period almost no other fresh-picked oranges come on the market. American Egyptian cotton, bred from varieties introduced by the Department scientists from Egypt some 20 years ago, supplies the longest and best Egyptian cotton needed by American spinning mills and meets a growing demand by the manufacturers of high-duty automobile and truck tire casings. Tung-oil trees, first introduced by the Department in 1905, are the basis of an expanding production of tung oil, an important constituent of high-grade varnishes.

Erosion Studies Reveal Appalling Soil Waste

THE largest man-made gulley in the Western Hemisphere lies 8 miles west of Lumpkin, Ga., and it is no credit to the United States of America whatever. It is 200 feet deep. The drip from a barn roof started it 50 years ago. Now that it has got its growth it has swallowed the barn, a schoolhouse, a tenant house, and a graveyard. There are other chasms nearly as large and voracious in that same vicinity. In five Alabama counties gullying and sheet washing have worn out 500,000 acres of formerly productive land. Such erosion annually steals 3,000,000,000 tons of soil from our farms and pastures. This means a direct monetary loss to farmers of not less than $400,000,000 every year, showing up in reduced yields, abandoned land, damaged highways and reservoirs, and irrigation ditches and culverts choked with erosional debris. That had to be looked into. The Department of Agriculture started an investigation.

Gulleying has destroyed 90,000 acres of once good farm land in a single county of the piedmont section of South Carolina. Farming went on in this county for nearly two centuries. It is no longer possible in this large gullied area. Former fields are chiseled into ravines which often expose the bedrock. One farm of 1,000 acres, much of which was not cleared of virgin timber until after the Civil War, has today hardly an acre of good land left. It was once a magnificent plantation. No one lives there now. The palatial home has tumbled into ruins. Everything is desolate and deserted. The surrounding country is much the same.

Erosion has so damaged nearly 200,000 acres in one county of southeastern Ohio that the land is no longer cultivated. Half of it is not used for any purpose. First it was farmed and then turned over to pastures. Now the fences have fallen and only poverty grass, goldenrod, and weeds appear. Erosion that causes gulleying in one place may convert nearby land into swamp or may smother it with sand. This has happened to 46,000 acres of stream bottom in one South Carolina county. The land was formerly the best of the entire State.

These are extreme examples of destructive erosion, but the damage is not localized. Erosion has removed most of the precious topsoil from nearly a third of our cultivated area. On certain moderately steep slopes some soil types erode so fast that the land cannot be used for clean tilled crops except by strip farming, or with terracing and the use of cover crops and soil-saving crop rotations. Land robbed of its rich surface layer and badly gullied often cannot be reclaimed.

Perhaps no other nation ever permitted its agricultural lands to go to waste as quickly as the United States. Erosion has ruined agricultural lands elsewhere, but usually only after thousands of years of use. This country has allowed enormous impoverishment and destruction during only two centuries of cultivation. Most of the damage indeed has come about in the last 50 or 75 years. It is a

result partly of peculiarities of soil and climate and partly of carelessness in farming. We use land planlessly. We occupy all degrees of slopes indiscriminately for every purpose. Regarding our vast domain of agricultural land as virtually limitless, we pay little attention to soil conservation.

Rain water running wild across the slopes of America's farm lands inflicts upon us a tremendous damage that we scarcely stir ourselves to prevent. Few reflect, on seeing muddied water flowing away to the sea, that the discoloration comes from irreplaceable soil material. The sight of farm products floating wastefully out to sea would cause indignation. Not many people worry because the source of these products drifts away.

Uncle Sam, however, has finally started worrying. The Federal Government, through the Department of Agriculture and the State experiment stations, is carrying on a program of study and control. With funds first made available in 1930, it has established erosion experiment stations in Iowa, Kansas, Missouri, North Carolina, Ohio, Oklahoma, Pennsylvania, New York, Texas, Washington, and Wisconsin.

Practical measures to prevent erosion losses are being developed at these stations. In 41 States the Government, in close cooperation with farmers, is carrying on 135 demonstration projects where these measures of control are applied directly to the land. In 38 States C. C. C. camps under direction of the Department also are engaged in actual erosion-prevention work on agricultural land.

This national program has already produced significant results. It has awakened thousands of farmers to the importance of conserving their soil. Some 15,000 farmers are cooperating actively by furnishing their lands for demonstration purposes, and more than 20,500 other farmers have offered to cooperate. Others, on their own initiative, are carrying out the practices they have seen demonstrated in the project areas.

Erosion specialists in the Department are attacking the problem in every possible way. They use vegetative control measures when such methods are most effective. They use engineering measures wherever necessary. And they use both in combination. For example, prepared outlets at the side of terraced fields are heavily sodded to prevent the concentrated flow of water from carving out a gully. Gullies are controlled by the use of inexpensive check dams, the use of trees and other soil-binding plants. The program calls upon the knowledge and training of the soils expert, the agronomist, the agricultural engineer, the forester, the farm-management specialist, and other technologists. Because the restoration and maintenance of vegetative cover is essential both to soil conservation and to wild life conservation, the plants used by the Department to hold the soil from washing and blowing are selected with consideration for their benefit to wild life.

Hand in hand with the erosion-control demonstration operations go erosion control research activities. These include the exact measurement of losses, of the rate of run-off of rain water, and similar processes under varying conditions of

soil, slope, precipitation, and ground cover. Control methods are devised and tested for their effectiveness under these same conditions. In livestock sections, land is subject to various conditions of grazing and the soil-saving power of different grasses and forage crops is gaged. Results of these investigations pave the way for erosion-control operations. Quantitative measurements at the soil erosion experiment station at Guthrie, Okla., show, for example, that a grass cover on a given slope and soil type is 625 times more resistant to erosion than a cultivated crop, like cotton, and almost 15 times more effective in conserving rainfall.

Federal and State Cooperation Fruitful

IN much of its work the Federal Department cooperates with State agencies. Various laws tie Federal and State efforts together in research and in agricultural extension. Thus the Hatch Act of 1887 maintains agricultural experiment stations at the land-grant colleges and provides for their supervision. The Adams Act of 1906 and the Purnell Act of 1925 provided additional funds for the experiment stations. These measures require that the work be supervised by this Department so as to avoid duplication. The Department and the State stations cooperate under written agreements in about a thousand research projects and, less formally, in many other undertakings. Thus two great systems of agricultural investigation, functioning in close harmony, make a concerted attack on problems involving diverse conditions and requiring approach from many angles. The Department and the State stations share credit for some of the most important developments in agricultural science.

Typical of the cooperative research thus conducted is an economic and social study now going forward in the southern Appalachian Highlands. The world depression specially emphasized the need for coordinated study of agricultural economics and rural sociology. The southern Appalachian study involves the cooperation of the United States Department of Agriculture and the agricultural experiment stations of Kentucky, North Carolina, Tennessee, Virginia, and West Virginia. It will correlate research in the natural sciences with economic and sociologic studies. Specialists in the physical and biological fields study production problems, while economists and rural sociologists attempt to draw up plans and specifications for better farm incomes and better standards of living.

Another large cooperative enterprise deals with factors affecting the quality and palatability of meat. Three bureaus of the United States Department of Agriculture and 26 State experiment stations are cooperating in this study. The investigations deal with factors such as breeding, age, sex, market grade of feeder, specific feeds and rations, and processing and handling factors, and include grading, cutting, nutritive value, color, cooking, palatability, and other tests on the finished animals, dressed carcasses, or meats. Already the study has produced results of broad scientific significance and practical application. It has shown, for example, that under certain conditions retarded growth lowers the palatability of meat; that the meat from different breeds does not vary much in palatability, though the meat from individual animals within the breed does; that the grade of the beef carcass is closely related to the thickness of external fat or the degree of finish; and that if a moderate quantity of kidney and crotch fat and of intermuscular fat, with thick covering of external fat, is desired in the carcass of the typical well-bred, well-fed heifer calf, it should be slaughtered when weighing about 725 pounds and the steer when weighing about 850 pounds.

Corn Breeding by New Methods Boosts Yields

INVESTIGATIONS in the Department and in many of the State agricultural experiment stations, coupled with advances in the sciences of genetics and cytology, have revolutionized corn-breeding methods, practically within the last quarter of a century. Extensive programs of corn improvement based on corn-breeding methods developed in the cooperative investigations have been under way for a dozen years or so, particularly in the Corn Belt. They have produced strains of corn that in yield and quality surpass any of the varieties previously grown.

The corn breeders first demonstrated the inadequacy, or the great limitations, of the older corn-breeding methods. Then they experimented with various systems of selection during inbreeding and crossbreeding, and with exact matings, under definite control by hand-pollination, between individual plants. By selection and self-fertilization methods the investigators obtained the best possible true-breeding lines. They did not get improved corn at once. On the contrary, even the best of the lines so developed were inferior to ordinary corn. From the corn breeders' standpoint, however, the new lines had a supremely valuable characteristic. They bred true for such good characters as they had.

In other words, the lines developed by selection and self-fertilization gave the corn breeder his first fixed material, and allowed a certainty of progress never possible before. The next step was to test the "selfed" lines in hybrid combinations. It was necessary to find those that yielded most, had the soundest grain, the stiffest stalks, and the greatest resistance to drought, pests, and diseases. Hybrids so obtained were then planted to produce commercial crops. But only the first hybrid generation, the seed from the direct crossing of unrelated strains, has maximum value. Only this generation should be called hybrid seed corn. Second-generation seed yields from 10 to 25 percent less. Hybrid seed must therefore be produced anew for each season's use.

These corn-breeding experiments have involved the isolation and testing of hundreds of true-breeding selfed lines possessing various characters of economic or scientific importance. Hybrids have been produced that yield in different localities from 20 to 40 percent more than the best open-pollinated varieties.

But testing thousands of hybrids takes time. It does not suffice to take the results of a single season. The investigators must demonstrate that certain ones can be relied on year after year. As yet hybrid seed corn is available for only a few localities. But hybrids adapted to other localities are being tested, and should be available in practically all parts of the Corn Belt within 5 years.

Thereafter these hybrids should play an ever-increasing part in reducing production costs. They will permit the growing of more corn on fewer acres.

The Citrus Grower and the Ladybird

THERE is one song the California citrus grower never wants to sing. He never has the least impulse to warble "Ladybird, ladybird, fly away home." On the contrary, he wants the ladybird, or at any rate the Australian ladybird, to stay right in his orchards, because this insect saved the orchards once from a dangerous imported pest and stands guard still against the enemy.

Entomologists from the Department of Agriculture brought the ladybird to California so that it might attack the fluted scale (*Icerya purchasi*), which was the most destructive of all citrus pests in the State. The attack succeeded brilliantly.

The fluted scale reached California from Australia about 1868 on an importation of an Australian plant. It attacked citrus and other plants and spread rapidly. It whitened the citrus trees and weakened many orchards so that they had to be destroyed. The female secreted a dense, fluted, cottony mass as an egg sack, which was practically impervious to the insecticides then used. So destructive was the pest that the very continuance of the citrus industry seemed threatened. This was the situation when the Department of Agriculture took a hand in it in 1886.

Dr. C. V. Riley, the Department's entomologist, endorsed a proposal for a search in Australia for the natural enemies of the fluted scale. By authorization of the State Department, Albert Koebele went to Australia for that purpose. He sent to California many thousands of living parasitic and predacious enemies of the fluted scale and other scale insects.

In 1889 he extended his search to New Zealand, where he collected a number of ladybirds that were feeders upon citrus insects. Among them was a ladybird called *Vedalia Novius cardinalis*, which Mr. Koebele had also found in Australia. He sent numbers of the beetles to California, where they were placed on a cage-covered tree.

They increased with amazing rapidity, and quickly stripped the tree of its scale covering. Enthusiastic over the finding, State entomologists bred colonies of the ladybirds and distributed them throughout the State. They were astounded at the result. In a short time the fluted scale had been practically exterminated.

Naturally the complete eradication of a dangerous introduced insect cannot be taken for granted once the invader has been established over a wide area and has made its home on many different plants. Nevertheless, California has easily and fully maintained control over the fluted scale for 45 years by keeping a laboratory-bred stock of the ladybirds available for prompt distribution to any point where the fluted scale may appear.

This same ladybird has been established with like benefit in many other citrus areas throughout the world.

Fertilizer Studies Show Rarer Elements Are Important

SCIENTISTS from the Department inquired into the difficulties of tomato growers on certain soils in Florida. These soils consist largely of calcium carbonate deposited from sea water, but contain also from 5 to 10 percent of organic matter, small amounts of the usual plant foods, and traces of iron, and a few other minerals. The areas are periodically covered with sea water each year. After the water recedes the growers mark off rows, drop tomato plants a certain distance apart, and throw on some manure. Until recently this was the only method that succeeded. If no manure was used, or if the soil was stirred up, the tomatoes would not grow well, and no amount of commercial fertilizer would help the situation.

Analysis showed a lack of manganese. Applied in sufficient amounts, the manure supplied this want, because it was obtained from regions where manganese is common. It was found practicable to replace the manure with manganese. Growers on these Florida soils now get good crops of tomatoes with manganese and other fertilizer salts alone. This experience and tests in other localities indicate that manganese is indispensable to the normal growth of plants. Manganese occurs plentifully in most places, and need not be supplied artificially. But the knowledge of its role has prompted investigation into the function in plant growth of zinc, copper, nickel, and boron.

Both animals and plants contain in their structures, in varying quantities, practically all the known chemical elements. It may even be that all these elements are essential. As to that, science does not yet speak positively. It does say positively, however, that many more constituent substances are necessary to the health of animals and plants than was formerly believed.

In the case of cultivated plants, if the soil does not contain what is necessary, the farmer must use fertilizers, and the skill and economy with which he does this may determine his commercial success. Recent research in the Department has thrown much new light on the fertilization problem, not merely from the standpoint of plant-food needs but also from the standpoint of how to fill these needs efficiently at low cost.

Investigators believe unusual chemicals would be effective on many soils. It is significant that the use of Bordeaux mixture as a spray for potatoes, citrus fruits, and other plants has been followed by crop improvement. Bordeaux mixture contains copper.

Until quite recently scientists thought only 10 elements were necessary to crops. These were nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, carbon, hydrogen, oxygen, and iron. In fertilizer practice they considered it sufficient to apply nitrogen, phosphorus, and potassium, because the other seven elements are usually present in adequate amounts. Only in the case of the three principal plant-food elements was it known that soils could be seriously deficient.

Modern research has shown that magnesium, iron, and sulphur are lacking in some soils. What is more, it has indicated that in some regions certain of the less common elements, such as boron, arsenic, barium, chromium, strontium, cæsium, titanium, and silicon, may be important in plant and animal nutrition. When ordinary fertilizers fail to work, the trouble may be a shortage of some rarer essential chemical.

How important it is to know specifically, rather than merely in a general way, what particular fertilizer certain crops need was demonstrated by the Department to the substantial profit of sugar-beet growers in the Arkansas River Valley of Colorado.

Ten years ago the industry faced decline in both yield and sugar content of beets. The beets grown in the valley had deteriorated. Fertilizer experiments had shown no results and the growing of sugar beets had ceased to be profitable. Two sugar factories in the valley had closed. Some of the big companies operating in Colorado themselves conducted elaborate fertilizer experiments. The Colorado Agricultural Experiment Station studied the problem also. Every test had shown that the trouble was not a lack of nitrate. Indeed, certain places in the valley had too much nitrate.

Investigators from the Department cooperating with the Colorado station attacked the problem by "triangle" experiments, in which all possible combinations of the three plant foods, nitrogen, phosphoric acid, and potash, were applied singly, in combinations of 2, and in combinations of 3.

Altogether the experiments included the use of these fertilizer elements in varying proportions in 21 different combinations. Results showed that what the soil most needed was not nitrogen or potash but phosphoric acid. Very small applications of phosphatic fertilizers enabled growers to increase their yields of sugar beets by several tons per acre.

In 1923, following the Department's experimental demonstration, beet growers in Colorado used a single carload of fertilizer experimentally. Since then the tonnage used has steadily increased. Applications of phosphatic fertilizers in the right amounts increase the yields of beets by an average of 3 tons an acre on these Colorado soils, and the practice of fertilizing sugar-beet soils with phosphate is extending throughout the sugar-beet belt of the Midwest.

Cooperative investigations of strawberry soils on the Atlantic Coastal Plain revealed that quickly available fertilizer materials applied in late summer result in healthier and more thrifty plants in early spring, and these plants produce larger yields of good-quality berries than plants to which fertilizers are applied in winter or early spring in several applications. This change in practice has netted berry growers considerable profit. Manganese sulphate is effective in improving the vigor of citrus trees, character of foliage, color, and quality of fruit, investigations in Florida showed. Large areas of truck lands, which formerly were unproductive, have been made to produce profitably by the use of manganese sulphate.

Chemists Find New Uses for By-Products

NOT many years ago the citrus growers of California, particularly the lemon growers, found themselves in a bad situation. They were loaded down with surplus fruit. There seemed no way out but ruin. They applied for help to this Department, which assigned a horticulturist to study the problem. He tried to find ways of utilizing the surpluses, which consisted largely of good but oversized and odd-shaped fruits. He got aid from the Department's chemists. In a special laboratory established at Los Angeles the chemists studied problems in the utilization of lemons, oranges, and other fruits. They developed methods of obtaining lemon oil, orange oil, citrate of lime, and citric acid from cull fruit. Also they outlined processes for manufacturing pectin, marmalades, stock feeds, and other valuable by-products. Citric acid goes extensively into the preparation of soft drinks and drugs. Pectin helps the juices of some fruits to jell, and is employed in making jellies and jams from fruits that have not enough of the jelly-making property.

Nonagricultural capital was the first to profit from these citrus investigations. Soon, however, the growers became interested, and put their cooperative organizations into the by-products business. The Citrus Growers Exchange of California established two large by-product plants, one of which in a recent year utilized more than 40,000 tons of cull lemons and produced 2,000,000 pounds of citric acid, 65,000 pounds of lemon oil, and 30,000 pounds of pectin. A noncooperative organization used 10,000 tons of surplus oranges and produced 50,000 pounds of orange oil. This was obtained from materials which, prior to the Department's discoveries, were waste products. One plant used to pay a man $100 a month to cart citrus pulp away and get rid of it. This plant now processes the pulp and sells it for stock feed. The citrus investigations not only dragged a great industry from the shadow of bankruptcy, but greatly widened its market and helped to make the United States independent of foreign sources for lemon oil, citric acid, and pectin.

In recent years the Department has paid great attention to the utilization of farm by-products. Such by-products constitute more than 60 percent of the material annually produced from the farms. The principal farm by-products are cornstalks, corncobs, cereal straws and hulls, cotton stalks, cottonseed hulls, and flax straw. These materials are not wholly wasted at present. They have a value as feed for livestock and as fertilizer on the farms. It pays to sell them for industrial use only when the farmer receives more from their sale than they are worth to him in feed and manure. On the other hand, the manufacturer cannot pay more for them than for other raw materials which are perhaps better suited to his purposes. This is the real stumbling block in the way of the industrial use of farm wastes. So the problem has both chemical and economical aspects. It is

necessary not merely to find new uses for these materials but to find new uses that will pay.

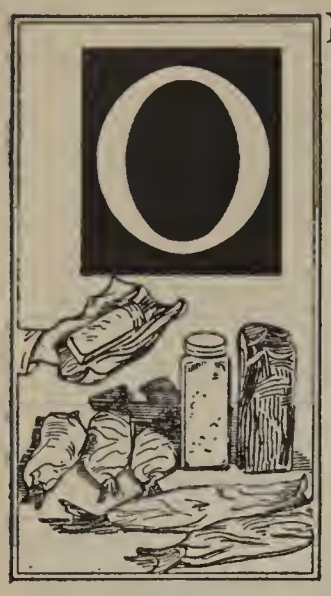
Much work has been done toward solving this knotty problem. Mill-scale experiments conducted by the Department showed that excellent white paper can be made from bagasse, the waste from sugarcane after the sugar has been extracted, and also from straw and cornstalks, but it has also shown that such use is not yet economically practicable. However, one commercial mill makes insulation board from wheat straw, another makes it from cornstalks, while still another has made immense quantities from sugarcane bagasse. These enterprises resulted largely from the Department's investigations. Another mill persisted in trying to make bleached pulp from cornstalks against the Department's advice. It failed. Using dilute nitric acid as the pulping agent, the Department recently developed a process for making high-grade cellulose from bagasse, which may prove to be economically feasible. High-grade cellulose is the basic material for rayon. From 250,000 to 500,000 tons of bagasse accumulate each year at the sugarcane mills of the United States. About 20 percent of it goes into the manufacture of insulation board. The new process for developing cellulose from bagasse may make it possible to find a market for considerably more of the latter.

The Department's chemists recently devised a method of producing high-quality starch from cull sweetpotatoes. This starch is suitable for use as a sizing in the cotton-textile industry. In some seasons a large part of the sweetpotato crop is classed as cull and finds no market. Twenty percent or more of the sweetpotatoes may be too large or too small or unmarketable for some other reason. Moreover, surplus sweetpotatoes that are normal often constitute a problem. The profitable utilization of cull sweetpotatoes would increase the returns to sweetpotato growers by several million dollars annually. Some cull sweetpotatoes are fed to livestock, but this use comes nowhere near absorbing the supply. Commercial production of sweetpotato starch is now being undertaken.

Chemical research in the Department and in cooperating institutions has done miracles in the utilization of farm materials. From lignin, one of the principal parts of woody plant tissues, the Department has produced dyes that are more fast than were the first dyes produced from coal tar. It has developed cheap methods of producing furfural from oat hulls and other farm by-products. Furfural was formerly imported from Germany at $30 a pound. Today, as a result of the Department's work, it sells in this country at as low as 10 cents a pound.

This by-product has a by-product of its own. Originally the cottony fuzz on the cottonseed was a nuisance to the oil extractor. Today it is the basis of a great industry. From fuzz (or linters), rayon, a product with a silklike look and feel, is made. This discovery of making rayon is an accomplishment of the chemist, made in the chemical exploration of cellulose. Linters were first used in making mattresses, batting, high explosives (nitrocellulose), etc. They enter now into the manufacture of automobile tops, substitutes for leather, brushes, combs, mirrors, camera films, sausage casings, fine paper, collodion and many other products.

Oil-Bearing Foods Keep Best In Green Containers



ON the roof of one of the Government buildings in Washington, placed where they will catch as much sunlight as possible, are 20 or 30 glass flasks containing samples of butter, salad oil, lard, pecans, cashew nuts, potato chips, mayonnaise, whole-wheat flour, corn meal, cookies, crackers, and other oil-bearing foods. They were all put there at the same time. There are 2 flasks containing butter, 2 containing lard, 2 containing nuts, 2 containing potato chips, etc.

In each case the food in one flask is rancid, while that in the other is not. The explanation lies in the fact that the flasks are not the same color. One is clear, like window glass, and the other is green. Green, by absorbing or deflecting all other colors of the rainbow, allows only green light to shine on the material in the flask and thereby delays the development of rancidity in oil-bearing foods.

This discovery, which has innumerable industrial applications, was made recently by a chemist in the Bureau of Chemistry and Soils. He observed, and partly explained, certain long-suspected relationships between light and decomposition. Other investigators had noticed similar relationships, without realizing their general significance. It had been known for a long time that light causes certain things to spoil. Manufacturers wrap chocolate in tinfoil to keep out the light. With the same object they put other products in tin cans, brown or amber bottles, and dark storerooms. Sunlight also affects milk and medicines. It hastens the photochemical decomposition of silk. It causes rubber to deteriorate, so that tire makers put red or black pigment in their tires in order to keep out certain light rays. Pharmacists have long been aware that certain drugs keep best in glass that is colored to shut out rays from the parts of the spectrum near the ultraviolet bands. In several cases these rays hasten decomposition.

This knowledge, however, was too vague for general use. Broadly, the only practicable way to prevent decomposition through the action of light was to exclude all light from spoilable products. That can be done by putting them in black containers. But black has decided commercial disadvantages. It was necessary to find out, for different substances, what light rays did the least harm.

When exposed to ultraviolet light from a mercury lamp, rice polish and bran became rancid in a few hours. When exposed to direct sunlight, they did not become rancid for several days. This difference showed that the ultraviolet light emanating from the mercury lamp was stronger than that from the sun. After observing this the investigator tried different bands of light separately. He exposed samples in different-colored cellophane wrappers and tested them also in darkness. Almost invariably such things as butter, lard, cottonseed oil, potato chips, and peanut butter became rancid after a short time in all the wrappers except the green and black ones.

Forest and Wild Life Conservation

THE European discoverers of North America found the woods in almost unbroken stands from the Atlantic to beyond the Mississippi, constituting a vast forest of some 822,000,000 acres. It sheltered herds of wild game, vast migrations of waterfowl, pigeons, and small birds. There was plenty of meat and plenty of timber.

The pioneer who grubbed the trees from the soil and fought the sprouts for years to clear needed plow land was easily convinced that the forests of the United States were inexhaustible. The hunter killing all the game he could use, and more, did not foresee the time when government would have to step in and save valuable species of birds and animals from extinction. For a century the people of this forest-born Nation seldom gave a thought to developing or conserving the woods or to planting trees on lands devastated by fire and erosion.

Awakening began with warnings from scientific men in the decades following 1850. The lumber business grew into industrial gigantism and by 1870 had an annual production worth $200,000,000. The white-pine forests of the Lake States were invaded and began to fall before ax and fire. There arose some talk of a future timber shortage as people began to pay freight.

But the public was still indifferent. Angry citizens objected to government interference with what they considered their privilege and individual right to cut timber on the open lands when and how they pleased. Loggers, miners, and settlers culled the best and often set fire to what remained of the woods, until virgin forest over large areas gave way to worthless brush. Erosion and floods followed.

In 1891 Congress passed a forest reservation act, and large tracts of public land in the West were made into forest reserves. However, at that time no provision was made for administering these reserves. Then in 1905 Congress recreated the forest reserves into the national forests, and transferred them from the Department of the Interior to the Department of Agriculture. Forest administration as well as scientific study was provided for. Conservation had come to appeal to the popular mind.

Gradually the Forest Service organization took shape. National forests, which now number 148 and comprise more than 160,000,000 acres in 30 States, were formed by Presidential proclamation and placed by the Forest Service under the control of trained supervisors. The forests were grouped into administrative regions corresponding roughly to the great natural forest regions of the United States.

The Forest Products Laboratory was established in 1910 at Madison, Wis., and technologists set to studying the properties of different woods and principles

and practices that would reduce waste and yield better utilization of timber. Regional forest experiment stations were established to study problems of timber management, reforestation, and protection.

The Forest Service called in scientists and experienced grazing authorities to systematize the administration of range lands, already overstocked and depleted in many places. Each summer the national forest ranges accommodate about 13,000,000 head of stock.

For timber sold on the national forests, for livestock-grazing permits, for rental of summer home sites and other uses, the Public Treasury receives a fair return. Part of these and other national forest receipts go to the States, in lieu of taxes, for county road and school funds.

Millions of tourists, campers, picnickers, and passing motorists visit and enjoy the national forests each year. Free public camp grounds are maintained for recreationists, and summer home sites may be leased in suitable areas. Many resorts and camps are operated under permit within the forests. Certain rough forest tracts within the national forests have recently been set aside as "primitive areas," where people may find natural wilderness conditions largely unmodified by civilization.

The Forest Service must be constantly prepared to battle with the forests' greatest enemy—fire. During periods of fire danger, lookouts are always on the watch, guards and "smoke chasers" and organized crews are alert to attack any fire discovered. The Forest Service has constructed hundreds of miles of forest roads, connecting with the Federal and State highway systems, and has built over 80,000 miles of horse and foot trails. So-called "truck trails" are being built as rapidly as possible for quick transportation of men and supplies to fight forest fires. Forest Service telephone lines serve all the forests. A light portable radio transmission and receiving set has been developed for use where there are no roads or telephones. Airplanes aid in fire patrol and in delivering supplies. Firebreaks have been constructed in many forests to help check the spread of flames.

Forests and wild life constitute one of the fundamental associations in nature. A forest well managed is a better forest and also a better home for game and small wild life. Discriminating conservation of wild life is a major objective and a practical necessity in wise use of the forests.

Many nonforested areas, however, formerly supported an abundance of big game, upland game birds, waterfowl, marsh-loving birds and mammals, and other forms of wild life. Nearly half a century ago the Department of Agriculture, through the Bureau of Biological Survey, began studies of the habits and economic status of the many species of wild birds and mammals. As a result, the need for conservation on purely economic grounds began to be generally known, and the value of many birds, including hawks and owls, which was not generally appreciated before that time, was better understood.

In 1900 game conservation became a function of the Department, with the passage of the Lacey Act, which made it a Federal offense to ship in interstate commerce wild animals or birds, entire or in parts, taken in violation of State

laws. Thus the Department has been enabled to cooperate with the States in conserving their valuable wild-life resources.

President Theodore Roosevelt, in 1903, established the first of a series of wild-life refuges under the jurisdiction of the Department—an island for water birds on the coast of Florida. Now numbering more than a hundred, these nonforest refuges dot the map in suitable areas along the Atlantic, Gulf, and Pacific coasts, along inland waters, and in the Territories of Alaska, Hawaii, and Puerto Rico. Two of the most extensive—each about 1,000 miles long—are in Alaska and Hawaii; another extends for 300 miles in four States along the upper Mississippi River.

To protect migratory birds common to both the United States and Canada, a treaty was negotiated with Great Britain in 1916. To make it effective. Congress 2 years later enacted the Migratory Bird Treaty Act and intrusted its enforcement and related investigations to the Department of Agriculture, Federal legislation has put a stop to spring shooting and sale of these birds, one of the most advanced wild-life conservation steps thus far taken. Reports from field investigators and from cooperating State officials and conservationists soon demonstrated, however, that mere restrictions on hunting would not long save the birds. Their concentration areas of marshland and water were becoming ever smaller with the extension of settlement and industry, particularly with increased and frequently unwise drainage operations.

In 1929, therefore, Congress made the migratory bird treaty further effective by passing the Migratory Bird Conservation Act, authorizing the acquisition of refuge areas for migratory game birds. Appropriation of funds to enable the Department to carry out the work over a 10-year period, with necessary maintenance thereafter, was authorized. Under this act the Department planned to preserve natural habitats of the various species by establishing approximately 100 game-bird refuges, averaging about 20,000 acres each. A number of these refuges have already been established, though the work has been slowed down by lack of funds. In the meantime, however, the Department has encouraged private organizations and individuals to make minor game-bird sanctuaries of small areas of marshland and water to supplement the more extensive refuge system when the program can be resumed.

The wild life of the Continent is still one of our greatest natural resources, and with intelligent conservation it is possible for us to continue to enjoy the species, as did our pioneer ancestors. Many forms can be propagated in captivity, notably some species of wild ducks and upland game, and some of the fur-bearing animals.

Some forms of wild life are locally detrimental to farming and stock raising, and even to the perpetuation of game. Methods of control, based on knowledge of the distribution and habits of the various species, have been developed by the Department and put into effect in cooperation with farmers' and stock-growers' associations. The Department is also able to aid individual farmers in solving problems presented by wild-animal pests.

Some New Outlets Found for Dairy By-Products

WHEN farm production overshoots market needs much of it goes to uses that would not ordinarily be considered economical. Corn occasionally replaces coal as fuel, wheat becomes a cattle and hog feed, and dairy products bulk larger in the livestock ration. At such times the discovery of new uses for agricultural products has exceptional interest and value. It prevents waste instead of simply shifting it, as happens when farmers reduce surpluses by cutting their acreage and their livestock breeding. That procedure cuts down the surplus of goods but increases the surplus of land, labor, and capital. It changes merely the form of the surplus.

The Department, in cooperation with the State experiment stations and with the dairy industry, has developed some important new ways of utilizing dairy by-products. When milk is sold for direct consumption or made into evaporated or condensed milk, all the constituents are utilized and there is no waste. It is far different when milk is made into butter. In that case only one of its constituents—the fat—is used. All the others go as by-products into skim milk and buttermilk. In making cheese the casein and the fat are used. The lactose, the soluble proteins, and the minerals remain in the whey.

The most efficient way to utilize skim milk is to reduce it to a powder by removing the water. From 8½ to 9½ pounds of dried skim milk can be made from 100 pounds of skim milk. The product sells in normal times at 8 or 9 cents a pound. Research in the Department contributed much to the processes used in making milk powder. One method sprays fluid milk, sometimes partly condensed, into a current of heated air, which removes the water and leaves the milk solids as a finely divided powder. Another method spreads partly condensed skim milk in a thin layer on steam-heated drums; the dried milk adheres to these and is scraped off. A vacuum process makes it possible to dry the milk at temperatures below the normal boiling point. Another method called the flake process passes partly condensed whipped skim milk on a wire belt through a heated chamber where currents of hot air dry the product in flakes.

Research in the Department has made important contributions to the use of dried skim milk in baking. Dried skim milk added to flour makes a more nutritious and more palatable bread. In the dried form skim milk has numerous other applications in food products. Casein has properties that make it useful in many ways. The Department recently developed a process for preparing casein which makes it more valuable in the manufacture of coated paper.

Dairy by-products contain a vast amount of lactose or milk sugar. The Department recently developed a method that promises to widen the market for lactose. This method causes the product to crystallize in a form known as beta lactose, in which form it is sweeter and more soluble than in the ordinary form.

Many Regulatory Laws are Administered by the Department

THE Department of Agriculture administers about 50 regulatory laws. Among the more important are plant- and animal-quarantine laws, the Meat Inspection Act, the Virus-Serum-Toxin Act, the Packers and Stockyards Act, the Renovated Butter Act, the Food and Drugs Act, the Tea Importation Act, the Import Milk Act, the Naval Stores Act, the Caustic Poison Act, the Insecticide and Fungicide Act, the Seed Importation Act, the Migratory Bird Treaty Act, the Lacey Act regarding wild life, the Alaska game law, the Cotton Standards Act, the Grain Standards Act, the Grain Futures Act, the Cotton Futures Act, and the Federal Warehouse Act.

These laws exist to eliminate or prevent social hazards, waste of resources, and economic abuses. They rest on ethical, sanitary, conservation, or economic reasons. They promote agricultural and social welfare by improving technical and commercial standards, by assuring the public of high-quality goods, and by protecting the consumer against fraud and the honest producer against unscrupulous competition. But the benefits are not limited to the prevention of abuses. Grain and cotton laws, for example, provide for fixed commodity standards which encourage the production of improved commodities and facilitate trade. The Food and Drugs Act promotes the consumption of processed articles by assuring the consumer that he may put confidence in them.

People nowadays often complain that there are too many laws, particularly regulatory laws. All the regulatory laws administered by this Department, however, meet obvious public requirements. Consider, for example, the Plant Quarantine Act. Prior to 1912 this country exercised practically no control over the entry of foreign plant pests.

In 1912 Congress passed the Plant Quarantine Act, and since that time the only pest of first importance known to have reached this country from other continents is the Mediterranean fruit fly. This appears now to have been stamped out. It was fought in the most extensive and the most vigorously pressed insect-extermination campaign ever waged in the United States. The fly appeared in Florida in 1929, and spread into 20 counties. It is perhaps the world's worst fruit pest. To permit the marketing of fruit during the infestation and to prevent the spread of the fruit fly to uninfested regions, the department developed heat and refrigeration methods for treating Florida fruit. These measures were so effective that no outbreaks occurred outside of Florida. All restrictions on the movement of Florida products were removed in November 1930, the last infestation having been found several months earlier in a dooryard in St. Augustine, Fla. Quarantines cannot guarantee immunity from invasion by plant pests, but the record since 1912 proves that they are tremendously effective.

Food and Drugs Act Protects Producer and Consumer

MANY governments have enacted laws to prevent the adulteration of foods and medicines. The ancient Athenians and the Romans had laws designed to prevent the adulteration of wine and certain foods. As early as the thirteenth century the English enforced laws to check the adulteration of staples such as bread and butter. And, on June 30, 1906, President Theodore Roosevelt signed the Food and Drugs Act, a national law which effectively controls interstate and foreign traffic in adulterated or misbranded foods or drugs.

This measure, commonly called the "pure food law," was passed as a result of persistent and strenuous agitation. Consumers had come to realize that the sale of adulterated foods and drugs was general and definitely harmful to their health and economic welfare. The pure food law was drawn up by the late Dr. Harvey W. Wiley and was introduced by Senator Heyburn, of Idaho. Briefly, its purpose is to prevent the sale of worthless, injurious, adulterated, or misbranded foods and drugs. The primary purpose of the law is to safeguard the public health. Its secondary aim is to prevent manufacturers from practicing economic cheats on the public through the sale of adulterated or misrepresented goods. It is enforced by the United States Department of Agriculture through the Food and Drug Administration, which also enforces the Naval Stores Act, the Caustic Poison Act, the Tea Act, and the Import Milk Act.

Twenty-five years or enforcement of the Federal Food and Drugs Act have made the American housewife label conscious. Twenty-five years ago women did not pay much attention to what was printed upon labels. There was little reason to do so, because when labels were not false or misleading they generally were not at all informative. Then, too, most foods were sold in bulk and not labeled.

Every housewife today should read labels, not only for her own protection but also as an aid to continued enforcement of the Food and Drugs Act. The food law requires that every package of food shipped interstate bear an accurate statement as to the quantity contained. The home maker goes to the store for, let us say, a package of breakfast cereal. She is shown two cartons of equal size. But if she reads the label carefully she may find that one carton contains 12 or 14 ounces while the other holds a full pound. Two bottles of vanilla, one large, one small, stand side by side upon the shelf. The larger one may have deceptive sides or bottom and actually contain only half as much vanilla as the smaller one. The words upon the label will tell how much vanilla is in each bottle.

There was a day—before the passage of the Federal Food and Drugs Act—when practically all manufacturers of foods preserved, colored, and flavored their goods artificially. Many women have heard of the poisonous character of the dyes used in some products, such as in highly tinted candies, before the law was

passed. Some of the dyes used were poisonous; most were objectionable. Milk and meat were "embalmed" with formaldehyde. Some manufacturers utilized both good and bad tomatoes in making tomato catsup. This was preserved with a generous quantity of benzoate of soda.

But this picture has changed. The food law discourages the use of any artificial preservative or color and makes illegal the use of harmful ones. Only two of the many chemical preservatives, which were used rather indiscriminately before the Federal law was enacted, now have any general use, and these are invariably required to be declared on the label. The two which have survived 26 years of enforcement and which are now occasionally employed are benzoate of soda and sulphur dioxide. Their continued use is attributable to the fact that extensive researches have so far not established that these preservatives, as used, render the foods detrimental to human health. Artificial flavors today are frequently used in beverages and in a number of food products, but these, too, must be declared. The pure food law permits the use of certain harmless artificial colors in commercially packed foods, but requires that these also be declared.

Mixtures, even imitations, are not always inferior to the pure article. Some people like a chicory-coffee mixture, or a cereal-coffee mixture, as well as pure coffee. Others find that an imitation flavor made with the coal-tar derivatives, coumarin and vanillin, for some uses, pleases them as well as genuine vanilla extract. But in order to assure the buyer of the protection and satisfaction that come from knowing exactly what she is getting, the food law requires that mixtures and imitations be clearly labeled. It also requires that when a food is labeled with a statement showing the country of origin, the declaration be truthful. When the buyer wants a can of Norwegian sardines, she can be assured that the name, "Norwegian," printed on the label truthfully tells where the fish came from.

Some housewives see, this year, a statement they have not been accustomed to upon labels of canned peas, peaches, pears, apricots, cherries, and tomatoes. A recent amendment to the food law gives authority to the Secretary of Agriculture to establish standards for canned foods, other than canned meat and milk, and further authorizes him to designate a form of label statement which will definitely tell the purchaser that goods which fail to meet the standards actually are substandard. That legend is "Below U.S. Standard—Low Quality But Not Illegal," in the case of vegetables, and "Below U.S. Standard—Good Food, Not High Grade," for substandard fruits. The legend does not signify that the goods are inedible, because if they were unwholesome or adulterated they would violate the food law. But the presence of these words upon a label indicates that the goods do not possess the aesthetic and tasteful qualities of foods not so labeled.

The Food and Drugs Act likewise protects buyers of drug products, and here, again, the purchaser is protected by reading labels. Briefly, the law requires that no manufacturer label his drug preparations with false and fraudulent claims as to their curative or remedial value nor with misleading statements as to composition or strength.

Road Building Had Small Beginning

FORTY years ago the Department of Agriculture set up a small organization known as the Office of Road Inquiry. Its purpose was to learn, so that it might teach, how to build, maintain, and administer roads. Roads at that time had chiefly to carry horse-drawn traffic, and, judged by modern standards, not much of that. Nevertheless, road building even then demanded scientific and technical knowledge. Accordingly, the Office of Road Inquiry studied the road situation, conducted road tests and road-building experiments, and made reports on road construction and maintenance. It built short "object-lesson" roads in many counties. Local road builders profited by the experience thus gained.

It was logical that the rise of the automobile and the resulting demand for more and better highways should present new tasks to the Office of Road Inquiry. It became the Bureau of Public Roads. In 1916 Congress undertook to assist the States by passing the Federal Aid Road Act. The new bureau was given the duty of supervising the construction of Federal-aid roads, a task for which its long study of road conditions throughout the country fitted it efficiently. In the tremendous expansion of highways that has since taken place, the Bureau has played an important part.

The great system of highways which now leads to all parts of the country involves organization, management, and engineering to a degree hitherto unknown in road work. Only a few States had well organized highway departments when the Federal Aid Road Act was passed. Many were entirely unprepared for extensive road building. The Bureau helped the States to formulate highway laws, to organize highway departments, and to prepare specifications and standards suitable for main highways. It set up testing laboratories and tested much of the material used, because only a few States had facilities for such work. In short, the Bureau developed a program of cooperation with the States in highway research, construction, and administration.

This policy speeded the improvement of a correlated Nation-wide system of main roads, caused main highway construction to be centered in efficient highway departments, maintained adequate standards of construction, and pooled available road knowledge among all the States. Congress in 1921 amended the Federal Aid Road Act in an important respect. It provided for the expenditure of Federal-aid money on a connected system of main highways not exceeding 7 percent of the total mileage in any State. The step had far-reaching effects. It prevented the dissipation of funds on short sections of disconnected roads and led to the creation of a road system that now reaches all parts of the country. You can travel from one end of the country to the other and into many out-of-the-way sections over continuous improved routes. Planning and coordination

by Federal and State officials under the Federal Aid Road Act made this possible.

There are approximately 207,000 miles in the Federal-aid highway system, of which Federal-aid funds have helped to improve 120,000 miles. The mileage improved with Federal assistance includes 650 miles of bridges with their immediate approaches, more than 51,000 miles surfaced with high-type pavements, more than 8,700 miles improved with intermediate-type surfaces, and about 47,000 miles improved with low-type surfaces. About 14,000 miles are unsurfaced but graded and drained to a satisfactory standard. It need scarcely be said that the type of surfacing depends upon the traffic, though, to be sure, the country's roads are by no means everywhere improved as much as the traffic justifies. It will take time and money to reach that goal.

The mileage of Federal-aid roads on which improvements were completed during the fiscal year 1933–34 reached the total of 14,780; in the preceding fiscal year improvements were completed on 13,255 miles. Of the 1934 total, 9,192 miles were classed as initial improvements; the remainder consisted of advanced stages of construction on 5,584 miles of road previously improved to some degree and 5 miles of reconstruction. The total cost of the projects completed during the fiscal year 1934 was $237,972,675, of which $84,592,580 was paid outright by the Government as regular Federal aid.

In the last 4 years Federal and Federal-aid road construction have employed thousands who would otherwise have been jobless. Moreover, the benefit has extended far beyond the number employed directly in this work. It has included perhaps twice as many more persons engaged in producing and transporting materials, machinery, and supplies. At the height of the 1934 season, road construction with regular Federal-aid road funds and funds provided for emergency relief resulted in direct and indirect employment of 800,000 men.

Economic Services Essential to Farmers

FARMERS need economic information as well as help in combating insects and other pests and in improving their field crops and livestock. Without data on markets and prices they work in the dark. Trying to make supply and demand balance under that handicap is hopeless. This has long been recognized. Congress provided for the collection of some agricultural statistics in connection with the first appropriation it ever made specifically for agricultural services. It took this important step in 1839, when it appropriated $1,000 "for collecting and distributing seeds, prosecuting agricultural investigations, and procuring agricultural statistics."

Nevertheless, for many decades the Department concentrated its research largely on the technic as distinguished from the economics of production. Its economic services are chiefly a development of the present century. These services have become extensive and varied. They combine the regular gathering of crop and market data with numerous related functions, such as commodity grading and standardization, shipping- and receiving-point inspection of farm commodities, seed verification, price analysis, and farm-management studies. In this branch of its work, the Department tries to help farmers establish a good balance among different crop enterprises and to adjust their total production to market needs. The economic services link up closely with production research, because changes in acreage and in livestock breeding accomplish their object more surely when the plant varieties grown and the livestock raised are superior types that may normally be relied on for stable performance.

Government crop reporting, as is well known, has been greatly expanded in response to an insistent public demand. Yet it has been constantly criticized. Every step in its progress has been hard fought. The opposition today is almost as strong as ever. Critics allege that early official reports are always above the final production, and that prices are adversely affected at marketing time. As a matter of fact, the July reports have been below the final report as often as above.

The idea that secrecy is better than publicity has largely disappeared from the business world, but it persists among many farmers. Industry furnishes much more information to the public through Government reports than does agriculture. It is an obvious fact that the condition of crops grown in the open along public roads cannot be concealed from experienced observers and that the abolition of the crop-reporting system would leave only the farmers in the dark. Crop information, since it is bound to get out somehow, is best obtained from a competent source which has no object in distorting the facts. Without Government crop reports, the farmer would be compelled to deal in the dark with buyers who would know the facts—the farmer would be in ignorance of them. Both sides should know the truth. Accuracy is the ideal. The Crop Reporting Board

strives constantly for accuracy, in the conviction that all interests will thus be best served.

Crop forecasts do not increase the speculative element in the agricultural markets. They have the contrary effect. Prices ultimately depend on tangible and measurable elements in the supply-and-demand equation, among which production is the most important. When production is known with approximate accuracy, the higgling on the market takes place within a narrower range, and prices throughout the marketing season more nearly express the true supply-and-demand values. Authentic crop information reduces the influence of misinformation or rumor, minimizes the chance for fraud, and lessens the excuse for wide differences of opinion as to crop values. All this is in the interest of the farmer.

In the case of cotton, information about the plant is obtained from many sources throughout its cycle. Reports are received on soil preparation, fertilizing, planting, replanting, chopping, plowing, spraying, picking, ginning, and marketing. Thousands of farmers and a large force of Federal and State statisticians cooperate in getting the necessary data. Several elaborate methods, each a check upon the other, determine the acreage. During the growing season regular reports come from the Weather Bureau and from Government entomologists and plant pathologists, so that damage from the weather and from pests and diseases can be figured. All this information, combined with records showing how the cotton crop has behaved under various conditions in the past, enables the Crop Reporting Board to issue production forecasts in which personal judgment or bias has little influence. On the major crops the personal element in crop reporting is a comparatively small factor. Production prospects can be indicated from crop data even in advance of planting, because farmers tend to base their acreage on the prices received for the last crop. High prices lead to increased acreage, and low prices to reduced acreage. This relationship is so uniform that the crop and price statistics of one season afford an important index of prospects for the next.

Crop reports frequently influence market prices materially. Hence a penalty of 10 years' imprisonment, or a fine of $10,000, or both, is provided by law for giving out information before the time set for the release of the official reports. Members of the Crop Reporting Board and employees of the Division of Crop and Livestock Estimates may not speculate in crops or in any products of the soil. Elaborate precautions prevent leaks. Prior to crop-reporting days all the pertinent information remains in a nonassembled form in a safe in the office of the Secretary of Agriculture. On crop-reporting days employees bring this material, sealed, to the board room, the doors and the windows of which are then locked and sealed. All means of communication with the outside, such as telephone, office buzzers, and the like, are disconnected, and guards are placed at the doors. Except to admit the Secretary shortly before the issuance of the report, the board room is kept locked until the moment when the report is released to the press. As an additional safeguard, the cotton exchanges suspend trading from 5 minutes before until 15 minutes after the time set for the release of the report.

Government crop reports come from a disinterested source, and the record proves that the information they contain reaches no one before it reaches the public. Hence only two questions can legitimately be raised. First, is it desirable that crop information should be officially gathered and disseminated? The answer is that no other method would equally inform all concerned. Probably even as things are, trade interests, with trained help for interpreting production data, learn more about growing crops than farmers do. In the absence of official reports, their advantage would be greater. The second question is—How accurate are the official reports? The percentage of error is small and tends steadily to diminish as the statistical basis of the estimates is enlarged and perfected. Seasonal and monthly, and sometimes weekly, price changes are forecast from production and other data with an expectation of about 80 to 90 percent accuracy. That is a higher average than the Weather Bureau claims for its 36-hour weather forecasts in the Washington district. It is certainly high enough to justify the claim that Government crop reports focus trade competition on real instead of speculative values.

The Market News Service of the Department gathers and distributes current information on supplies, demand, and prices of all of the principal farm products in more than 50 of the principal American market centers throughout the country. This service is operated by utilizing over 10,000 miles of leased wire and maintaining offices in the principal markets and also in producing centers. The Government's daily market reports are standard for trading in farm produce and are distributed by press, radio, and through the mail to producers and traders alike. These reports have displaced private market reporting on most commodities and are made essential by law in some instances. The information is gathered by trained specialists observing actual sales in the market and prices are quoted on the basis of grades and classes also established by the Government.

The Foreign Agricultural Service brings to American farmers from the principal foreign markets that either compete with or receive the American farm products in the great agricultural countries throughout the world. These reports enable the American farmer to understand foreign competition and demand.

Commodity standardization and inspection are among the Department's important economic services. The chief advantages of standardization are: (1) The establishment of a common language between buyers and sellers and other interested parties, and (2) actual separation of products into different grades of market quality. As a basis for trading, a common trade language is indispensable, particularly in the case of commodities like cotton and grain, which are handled very largely in futures contracts. In the case of many commodities not dealt with so extensively in futures, a large amount of business is still done on vague descriptions. This loose method gives rise to frequent disputes. One of the most conspicuous advantages of standardization is its power to prevent trade disputes. When differences arise unavoidably, standardization facilitates the settlement of claims.

Equally important advantages result from the separation of the product into different qualities. For instance, it enables cooperative-marketing associations to pool the products of individual growers, so that lots of different qualities may be assembled in commercially significant quantities. By this means it becomes possible to reflect quality differences in the prices paid to growers. Another advantage is that trading on a quality basis is a great stimulus to better methods of production. In fact, high-quality production cannot be expected of the farmer unless he is paid according to quality. Where no standards are recognized, the tendency of the markets is to pay a flat price based on the average value of the commodities received, a practice that penalizes the producer of superior goods.

Voluntary inspection and grading service have developed extensively along with the development of the permissive standards. Trained inspectors, at the request of financially interested persons, determine the grade and quality of products offered for inspection and issue certificates as to their findings. In trade disputes these certificates are prima facie evidence in all courts in the United States, and afford a basis for settlement in terms of definite commodity standards.

Economic information is assembled and analyzed in an understandable yet condensed form in the outlook reports issued by the Department. The annual outlook report, supplemented by special reports through the planting season, is a basis for extension work in agricultural economics which each year reaches millions of farmers, providing them with the facts upon which to plan production and marketing.

A Farm Program for the Nation

ECONOMIC information was always valuable to individual farmers and to cooperative groups having the means for putting it to effective use. But until 1933 the farming industry lacked a mechanism for developing the full usefulness of the Department's economic services. Such a mechanism was set up in May 1933 through the enactment of the Agricultural Adjustment Act. This measure required the Department to direct and administer a tremendous readjustment in agricultural production with the object of bringing production into line with demand and bringing farm and city prices into balance. During its 3 years of operation the Agricultural Adjustment Administration aided American agriculture in meeting a series of different and difficult problems.

During the first year of the Agricultural Adjustment Administration's operation its activities were chiefly concentrated upon obtaining relief from burdensome agricultural surpluses, accumulated when foreign markets for American farm goods largely vanished. These surpluses had depressed farm prices to ruinously low levels, thus curtailing farmers' purchasing power so that urban dwellers were deprived of the normal rural market for manufactured and processed goods. This national emergency was the immediate occasion for legislation creating the Agricultural Adjustment Administration.

When the drought of 1934 developed, the Agricultural Adjustment Administration demonstrated its capacity to cope with a different sort of emergency—one brought about by natural rather than economic forces. This was the second crisis. It called for corrective measures involving variations in the adjustment method. During the first year the surpluses in a number of agricultural commodities had required a reduction policy. In the second year drought restricted production of some commodities far beyond the point at which production control aimed. The policy therefore changed in that year to one of controlled expansion, and the Agricultural Adjustment Administration became an implement with which farmers acting in concert could attack problems created by deficient as well as by excessive production.

The third year of operation of the A. A. A. was devoted in considerable measure to laying the foundations of a long-term program. Because of adjustment programs, the drought, and other causes, farm price levels in 1935 were considerably nearer normal than those of 1932, and surpluses of most crops had been absorbed, thus lightening the burden of excess stocks on the market. It was consequently possible to turn from the urgencies of an emergency situation to the long-term factors behind the acute phase of the agricultural crisis. Throughout the year, emphasis was put on a transition from intensive to extensive farming, on a return to grass of acreage whose cultivation to row crops,

in a period of reduced export outlets, was rendering agriculture a double disservice in piling up surpluses and hastening erosion.

On January 6, 1936, the production-control programs of the Agricultural Adjustment Administration were terminated by a decision of the Supreme Court. On February 29, the Soil Conservation and Domestic Allotment Act became law, and a new program was initiated under that act.

The circumstances under which the 1936 program had its beginning, differed widely from those under which the first agricultural adjustment program was launched, 3 years earlier.

Farm cash income in 1932 was estimated at $4,377,000,000; for 1935, at $6,900,000,000. The cash income that remains after production expenses have been deducted, is a fairly accurate measure of the income available for farm family living and hence of farm purchasing power for city-produced goods and services. This income was about $1,473,000,000 in 1932 and had risen to about $3,575,000,000 in 1935.

The composite farm price of all groups of commodities in 1932 averaged 65 percent of the pre-war level. In 1935 it averaged 108 percent of the pre-war level. That did not mean that these commodities could be exchanged for more of the goods that farmers buy, than they could have been exchanged for in the 5-year pre-war period. The prices of the things that farmers buy had also risen from 1932 to 1935. But the exchange of farm commodities, which had an index of 61 for the year 1932, rose to an index of 86 in 1935. Agriculture's share of the total national income in 1932 had been 7.5 percent; in 1935 it was approximately 10.6 percent.

The rise in farm prices was naturally accompanied by a rise in the prices that consumers pay, but the latter increase was not in the same proportion as the former, because only a relatively small portion of the retail price of a processed farm product goes to pay for the raw material. The farmer's share in each dollar spent by a consumer for 10 of the principal foods increased from about 35 cents in 1932 to about 51.8 cents in 1935.

But studies of the wages of employed factory workers in the period from 1932 to 1935 indicate that rising food prices did not outrun the capacity of those employed workers to pay. At the bottom of the depression, food prices were about 60 percent of the 1928 level. In 1935 they averaged about 80 percent. Similarly, earnings to persons employed in factories averaged 60 percent of the 1928 earnings at the bottom of the depression; and during 1935 they also averaged about 80 percent of the 1928 earnings. Thus the higher prices were made possible by the increased capacity of the consumers to pay.

Furthermore, farmers who entered the new program in 1936 under the Soil Conservation and Domestic Allotment Act, started with the advantage of 3 years of experience in cooperative efforts involving farm programs.

The contracts signed in connection with A. A. A. production-control programs indicate that at least half of America's 6½ million farmers had direct experience, during those 3 years, with collective effort to reach common goals.

The concrete expression of this collective effort was found in the more than 4,000 county production control associations formed by contract signers in 48 States. The executives of these associations became, in 1934 and 1935, more and more the administrators of local phases of the programs.

The experience of the local production associations and committees of farmers, and that of the State bodies, extension services, land-grant colleges, experiment stations, and the like, that coordinated county and community efforts, has taken on particular future importance under the Soil Conservation and Domestic Allotment Act of 1936.

The new act envisages a temporary period of Federal administration running to January 1, 1938, during which time efforts to maintain and improve soil fertility and to effect the other purposes of the act shall be carried on through approximately the same channels as in the 3 years 1933–35. Beginning with 1938, however, the operation of agricultural programs will become a State affair. States desiring to participate must then (and may even sooner) authorize State agencies to carry on the work. Federal grants will thereafter not be made directly to individuals engaged in action in line with the purposes of the act, but will be made instead to States whose programs have been submitted to and approved by the Secretary of Agriculture. Thus local initiative and local responsibility will be even more important under the new act than the old.

The objectives of the Soil Conservation and Domestic Allotment Act include: (1) Preservation and improvement of soil fertility; (2) promotion of the economic use and conservation of land; (3) diminution of exploitation and wasteful and unscientific use of national soil resources; (4) protection of rivers and harbors against the results of soil erosion, for the purpose of aiding flood control and maintaining navigability; (5) reestablishment, as rapidly as the Secretary of Agriculture finds practicable and in the general public interest, of the ratio between purchasing power of the net income per person on farms and that of the income per person not on farms which prevailed during the 5-year period, August 1909 to July 1914, inclusive, and the maintenance of this ratio.

In March 1936 the relation between farm and city purchasing power, as defined in the act, was 89 percent [1] of parity.

In looking toward the soil-maintaining and soil-building purposes of the act, farming practices and the crops that farmers grow have been divided into two general groups—those that deplete the soil and those that tend to protect it from erosion or exhaustion, or actually to add to its fertility and productivity. The crops in the first group include, among others, the intensively cultivated row crops such as cotton, tobacco, and corn; those in the second group include grasses, legumes, forage plants, and wood lots.

To an alarming extent the fertility of America's farm land has been mined because American farmers have been under the drive of economic necessity to grow all they could and sell it, even when surpluses grew and prices fell lower and lower. Under this drive they have planted too great a proportion of their

[1] Preliminary February 15 figures.

land—in view of the effective demand for these commodities—in the soil-depleting crops. For these crops they have not received prices high enough to enable them to put back into the land the fertility which they had harvested and sold; or to enable them even to restore and conserve fertility by rotating crops according to good farm practice.

The average plantings of American farmers have been at the rate of about 3 acres of soil-depleting crops to 1 acre of soil-building crops; in total, about 300 million acres of row crops to about 100 million acres of grasses, legumes, and similar crops.

At this rate, potential productivity of the soil has been vanishing more rapidly and more steadily than is desirable from the standpoint of the farmer who makes his living directly from the soil, or from the standpoint of the consumer whose food and clothing must come from the same source.

The tentative objective of the 1936 program is to increase the acreage of soil-building crops by about 30 million acres. The 270 million acres remaining in soil-depleting crops is ample, at average yields, to supply the Nation with food and fiber products equal to domestic consumption for the 1920–29 period.

In order to compensate farmers for the immediate cash losses which they might sustain through use of the 30 million acres for soil-building rather than cash-producing crops, payments to farmers are provided for from the $500,000,000 appropriation authorized by the act.

These conservation payments are of two types: (1) A soil-maintenance payment for each acre, up to a maximum proportion of the individual farm maintained in soil-conserving or soil-building crops, or devoted to soil-conservation practices in 1936; and (2) a larger soil-improvement payment for each acre shifted from soil-depleting to soil-conserving or soil-building crops, up to a specified maximum percentage of the individual farm. These payments are adjusted from region to region and farm to farm according to the productivity of the soil. The establishment of maximum acreages to be shifted in any one region insures maintenance of adequate supplies of the commodities grown chiefly in that region and also guarantees that conservation payments will be kept within the limits of the budget.

While cooperating farmers sign no contracts under the 1936 program, in order to qualify for conservation payments, they must be able to demonstrate performance of the conditions indicated in the Soil Conservation and Domestic Allotment Act.

The Agricultural Adjustment Act of 1933 afforded to the producers of America's basic commodities an opportunity for collective effort in which approximately half of the country's farmers shared. The Soil Conservation and Domestic Allotment Act of 1936 extends the opportunity of voluntary participation in a conservation program to all of America's farmers. Moreover, the emphasis on local responsibility which increasingly characterized the production-control programs of 1933–35 is an outstanding feature of the soil-conservation

program. Flexibility, as among regions, States, and individual farms, is the essence of the new effort to improve the position of agriculture, and localized responsibility is no less central to the plan. Community conservation committees and State boards working in close collaboration with the State agricultural institutions are expected to evolve effective procedure, even during the temporary period of direct action by the Federal Government; after January 1938, at the latest, they will be directly responsible for the farm programs of the future.